



An area-analytical zoogeographical classification of Palearctic Unionaceae species

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KEY WORDS: Unionaceae, area-analytical division, fauna circles, West-Palearctic-, East-Palearctic-Elements, Pacific-Palearctic-Elements.

ABSTRACT: The zoogeographical classification for 31 *Unionaceae* species is given by using the area-analytical zoogeographical approach formerly successfully applied to terrestrial snails (Bába 1982). Studied species belong to the following genera: *Margaritifera*, *Margaritana*, *Unio*, *Potamida*, *Lanceolaria*, *Pseudanodonta*, *Anodonta*, *Cristaria* and *Corbicula*.

RIASSUNTO: La classificazione zoogeografica di 31 specie di unionacea è stata stilata utilizzando un metodo area-analitico. Le specie appartengono agli zonobiomi Boreale e Aboteale. Nei due maggiori gruppi dello zonobioma Aboreale - i.e. nei gruppi Palearctici dell'Ovest e dell'Est- gli elementi che si originano dalla Siberia orientale, centrale e occidentale, circa 20 specie, sono i più abbondanti. Sono necessarie ulteriori ricerche per determinare l'origine degli elementi della Mançuria e Sinopacifici nei gruppi della Siberia orientale (15 specie). I gruppi occidentali palearctici includono gli elementi centro-asiatici, ponto-caspici e olomediterranei, le specie Adriatico e Atlanto Mediterranee da rifugi secondari. La maggior parte di queste specie posseggono sia areali stabili che in regressione.

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INTRODUCTION

In contrast to numerous invertebrate taxa (*Plecoptera*, *Heteroptera*, *Odonata*, *Ephemeroptera*, *Trichoptera*, etc.), the area-analytical classification of freshwater molluscs has not been prepared yet. This gap is filled partly in this study for the *Unionaceae*, and was done so earlier for *Sphaeriidae* (Bába 1997).

MATERIAL AND METHODS

Earlier studies proved that the dispersal of terrestrial and aquatic organisms follow the same fundamental rules (De Lattin 1967, Varga 1975, Dévai 1976), that also holds true for plants and terrestrial snails (Bába 1986). The zoogeographical categorisation of species is further hampered by the limited information available on the subspecies distinguished by mostly anatomical traits. Albeit, the geographical distribution of subspecies carries important information on the history of the species (Heptner 1959). Different subspecies reported from the same area in the literature are sympatric, that in turn makes the subspecies status questionable. The dispersal of clams was enhanced by certain human activities, like fish introduction (*A. woodiana*) and waterway canalizations (*Dreissena polymorpha*). Occasionally, the glochidium may be transported by migrating birds. Nevertheless, the fossil-based dynamics for East Palearctic species is incomplete, which could serve with essential information on their distribution.

Generalised maps for the species (Fig. 2-5) were prepared by using literature data from the listed references. Fauna elements and refugium areas (Fig. 1) were classified after Dévai (1976). Due to the occurrences of various combinations, Manchurian refugia in East Siberia were collectively considered as East Siberian elements. For faunistic data from Spain, Portugal and Switzerland I thank F. Ramires and H. Turner. The help of S. Bagdi in drawing the maps is also acknowledged.

FAUNA GROUPS

The 31 studied *Unionaceae* species belong to the Boreal and Aboreal zonobiomes. The range of the Boreo-Alpine circumpolar (Holarctic) *Margaritifera margaritifera* from the Boreal zonobiome (Fig. 2) was drawn based on the work of Jungbluth et al. (1985). In the Aboreal zonobiome the most species rich fauna element group in the East Palearctis is the East Siberian, which includes many refugia. These refugia may combine with each other. The Amurian (Manchurian) elements are of particular importance, since these extended from the Amurian region into North China, Japan and Korea through the Japan Inner Lake during the Mindel Glaciation (De Lattin 1967). This resulted in the Manchurian-Sinopacific distribution pattern, which is temporarily classified as East Siberian elements based on De Lattin's theory.

Shadin (1952) gives no information on the subspecies. Species assigned to this category are *Margaritana middendorfi* Rosen 1926, *Margaritana sacchariensis* Shadin 1938, *Margaritana daburica* (Middendorf 1850), *Unio continentalis* (Haas 1980), *Lanceolaria grayana* Lea 1834, *Lanceolaria cylindrica* (Simpson 1900), *Anodonta beringiana* Middendorf 1850, *Anodonta encaphys* Hende 1879, and *Anodonta araeformis* Hende 1877. These fauna elements have stationary areas (Figs 2-3). Species with Manchurian-Sinopacific disjunct area are *Unio douglasiae* Griffith at Pitaeon 1833, *Anodonta woodiana* (Lea 1834) (adventives in Europe arrived with Amurian fish), *Cristaria plicata* (Leach 1815), *Corbicula fluminea* (O.F. Müller 1774), Fig. 3.

Anodonta anatina (Linné 1758) is a Middle Siberian element from the Angarian refugium (Fig 3). West Siberian elements most probably originated in the West Siberian meltwater lake, and then distributed toward east and - through a link with the Onega Lake - in the direction of Europe during the Riss glaciation (De Lattin 1967). Such species are : *Unio tumidus* Retzius


West-Palearctic Elements

1. South-mediterranean Elements
(Canarian, Mauritanian, Tyrrhenian,
Cyprean, Cyprian Refugial areas)

1. Holomediterranean Elements

1.a Atlantomediterranean
1.b Adriatomediterranean Refugial
areas

1.c Pontomediterranean

1.d South Italian

1.e euxin

2. Ponto-Caspian Elements

Ponto-Caspian Refugial area

West-Asian Elements

a) Pre-Asian Elements

3. Syrian Refugial areas

4. Iranian

b) Central-Asian Elements

5. Afghan Refugial areas

6. Turkestanian

East-Palearctic Elements

9. Mongolian Elements

Dzungarian Refugial areas
Mongolian-Altaic-Hangayn
Refugial areas

Daurian Refugial areas

Siberian Elements

a) West Siberian Elements

7. West Siberian Refugial area

b) Central Siberian Elements

8. Angaran Refugial area

10. c) East Siberian Elements

Stanovoy-Bureyan

Okhostkian Refugial areas

Kamchatkan

11. d) Manchurian Elements

Amurean

Sakhalin-Kurilian

Hokkaidon Refugial areas

Manchu-Ussurian

Pacific-Palearctic Elements

12. Japanese

13. Korean

14. Sino-Pacific Refugial areas

15. Sino-Tibethian

16. Yunnan

Note: The Korean Refugial area belongs to Manchurian elements by De Lattin 1967.

Fig. 1 System of freshwater refugial areas (fauna circles) and fauna elements in the Arboreal of Palearctic region (DE LATTIN 1967, Z. VARGA 1975) from GY. DÉVAI 1976.



1788, *Unio crassus* Retzius 1788, *Unio pictorum* (Linné 1758) and *Anodonta cygnea* (Linné 1758). The subspecies appear at the edges of the species' European ranges in Western and Central Europe and in the Pontis, arranged radially with the former Onega Lake in center (Figs 3-4).

West Palearctic elements include the Central Asian (Afghan) fauna group element *Corbicula fluminalis* (O.F. Müller 1774), which colonised Central Europe during the Pleistocene (Mindel-Riss interglacial) already, since its fossils have been found in Germany, Czech Republic and Hungary (Lozek 1964, Zilch et al. 1960). The species' recent range (Fig 4) is given by Girardi (1989-90). Central Asian elements originate from non-European territories of the great Mediterranean refugium (De Lattin 1967).

Stationary species in the Ponto-Kaspian group: *Unio stevenianus* Kyrnický 1837, *Unio sieversi* Drouët 1881, *Unio mingrelicus* Drouët 1881, *Anodonta cyrea* Drouët 1881 and the disjunct *Pseudanodonta complanata* (Rossmässler 1835). (Fig 4)

For Holomediterranean elements the following division can be made. Adriato-Mediterranean refugium: *Microcondylea compressa* (Menke 1836). Atlanto-Mediterranean refugium: *Margaritifera auricularis* (Sprengler 1793). Great Holomediterranean refugium: *Unio mancus* Lamarck 1819, *euxin Unio hueti* (Bourguignat 1836) and the regressing *Potamida littoralis* (Lamarck 1801). (Figs 4-5).

SUMMARY

The zoogeographical classification for 31 *Unionaceae* species was completed using the area-analytical method. The species belong to the Boreal and Aboreal zonobiomes. In the two major fauna groups within the Aboreal zonobiome - i.e. in the West and East Palearctic groups - fauna elements originating from East-, Middle- and West Siberian refugia are the most abundant, altogether 20 species. Further research is necessary to determine the origin of Manchurian Sinopacific elements in the East Siberian group (15 species).

The West Palearctic group includes Central Asian, Ponto-Kaspian and Holomediterranean elements, and Adriato- and Atlanto-Mediterranean species from the secondary refugia. Most of these species possess either stationary or regressive area.

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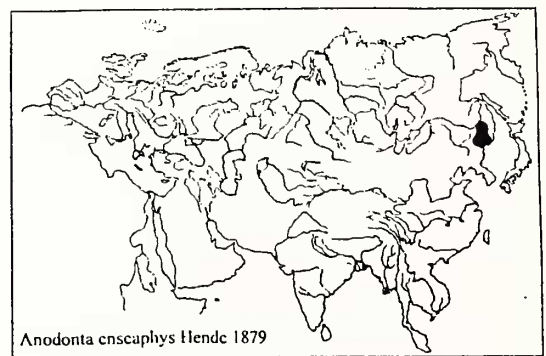
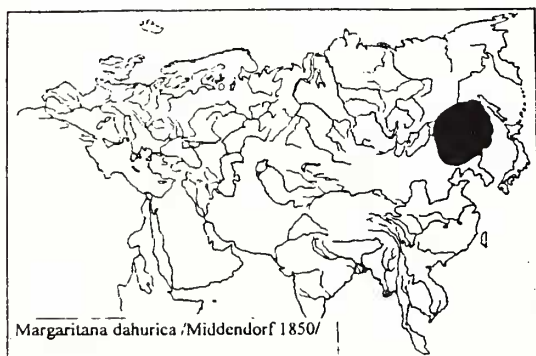
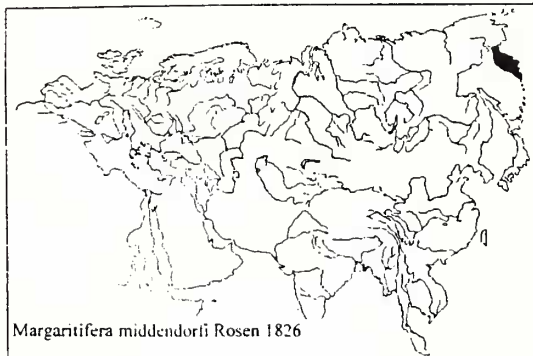
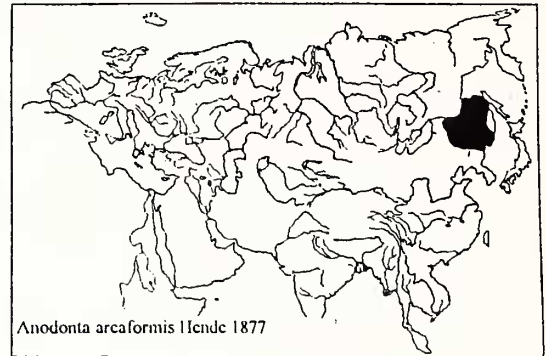
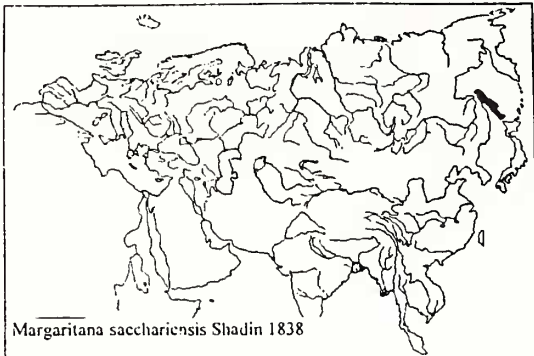
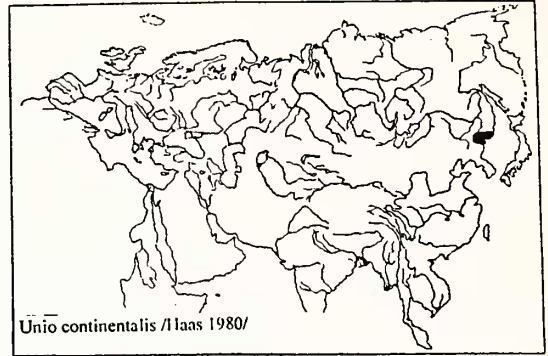
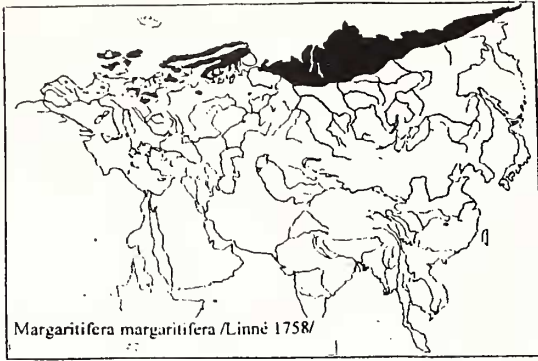


Fig. 2 The distribution-maps of the species of the *Margaritifera*, *Margaritana*, *Unio* geni, Boreo-Alpine, Eastern-Siberian (Amurian) fauna elements.

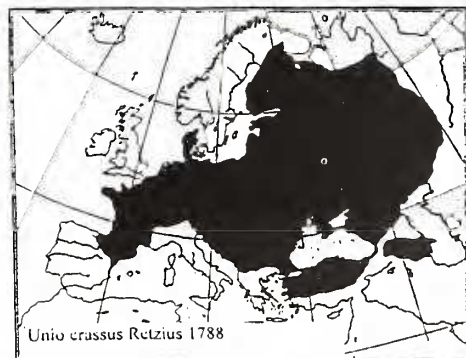
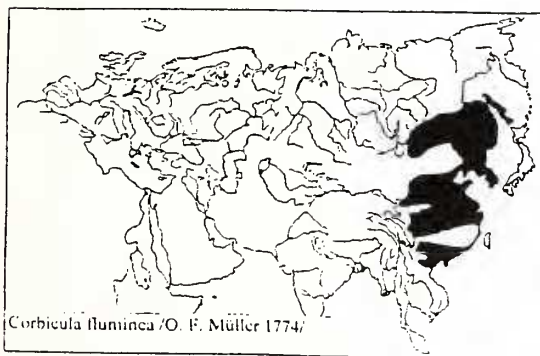
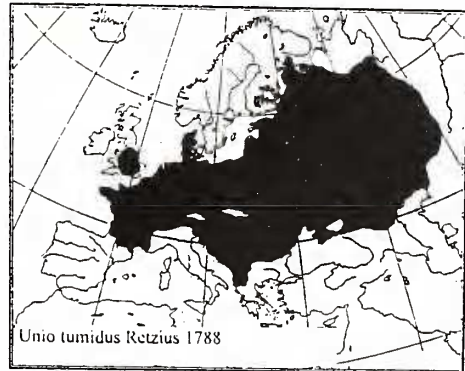
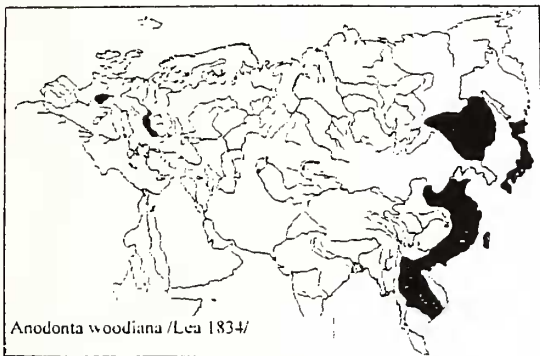
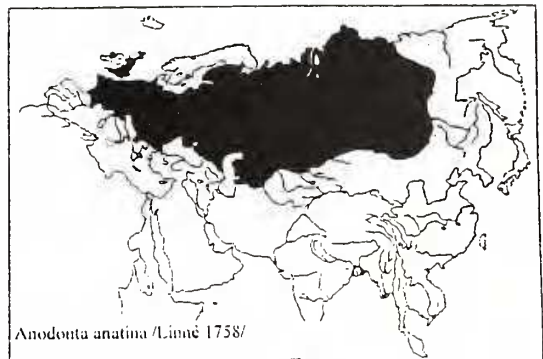
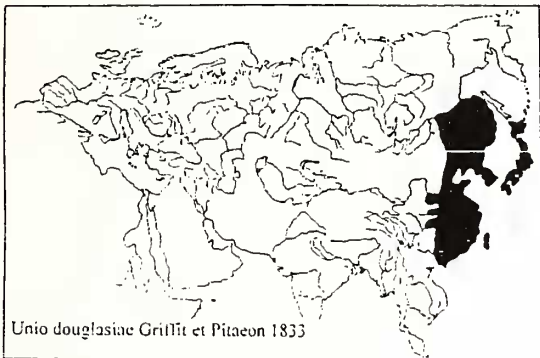
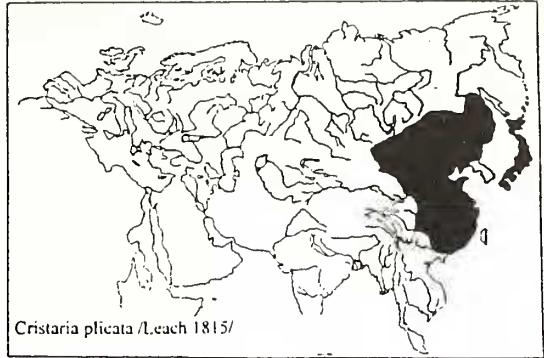


Fig. 3 The distribution-maps of the species of the *Lanceolaria*, *Cristaria*, *Corbicula*, *Unio* geni. East-Siberian (Mandsurian-Sino-Pacific), West-Siberian fauna elements.

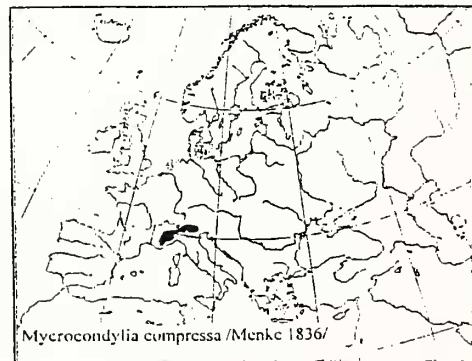
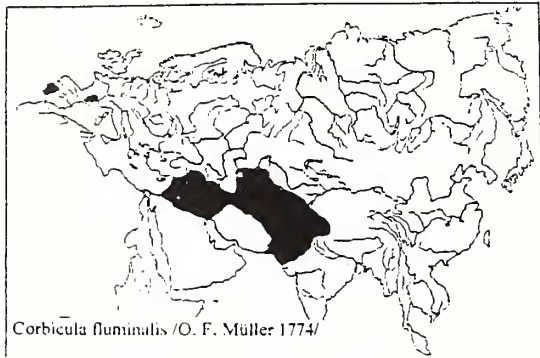
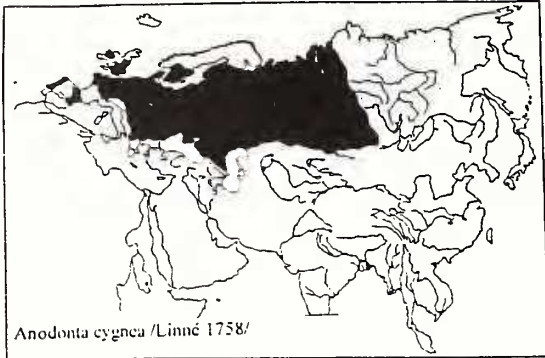
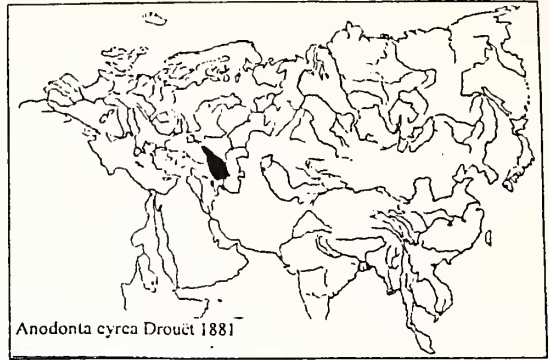


Fig. 4 The distribution-maps of the species *Unio*, *Corbicula*, *Pseudanodonta*, *Margaritifera* geni. Middle-Siberian, Ponto-Caspian, Middle-Asian, Adriatic-Mediterranean fauna elements.

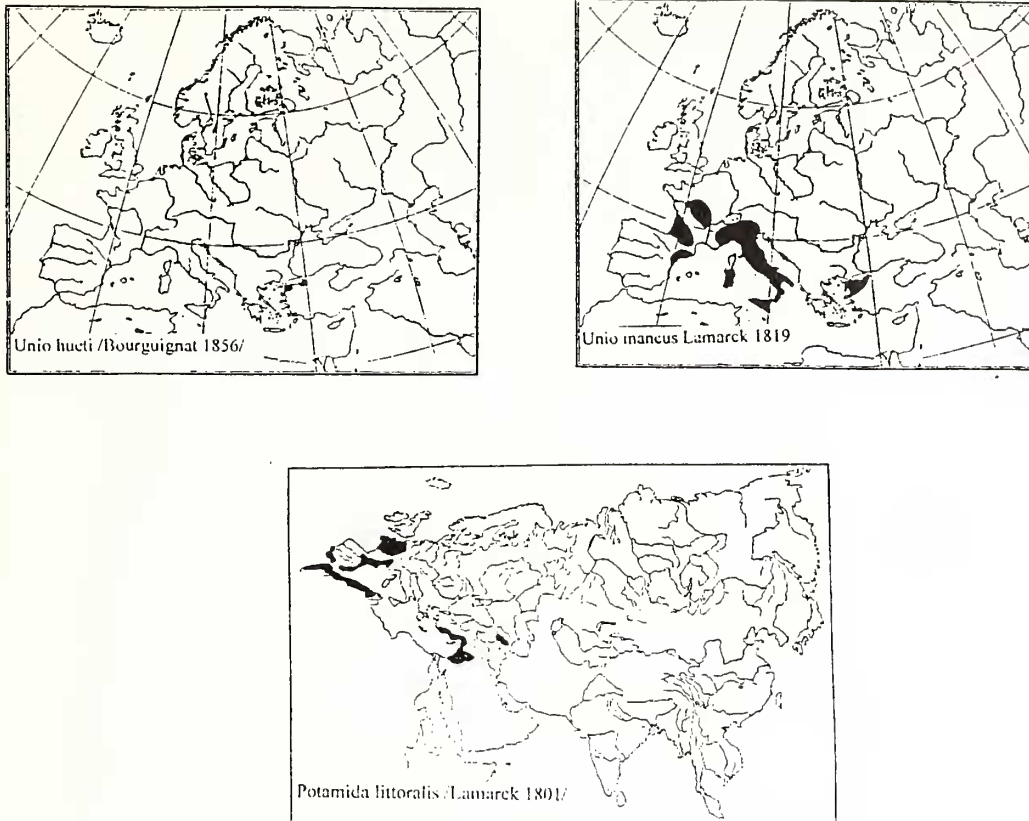


Fig. 5 The distribution-maps of the species *Unio*, *Potamida* geni. Holomediterranean fauna elements.

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